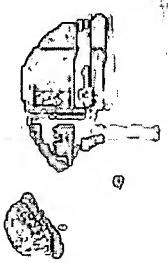
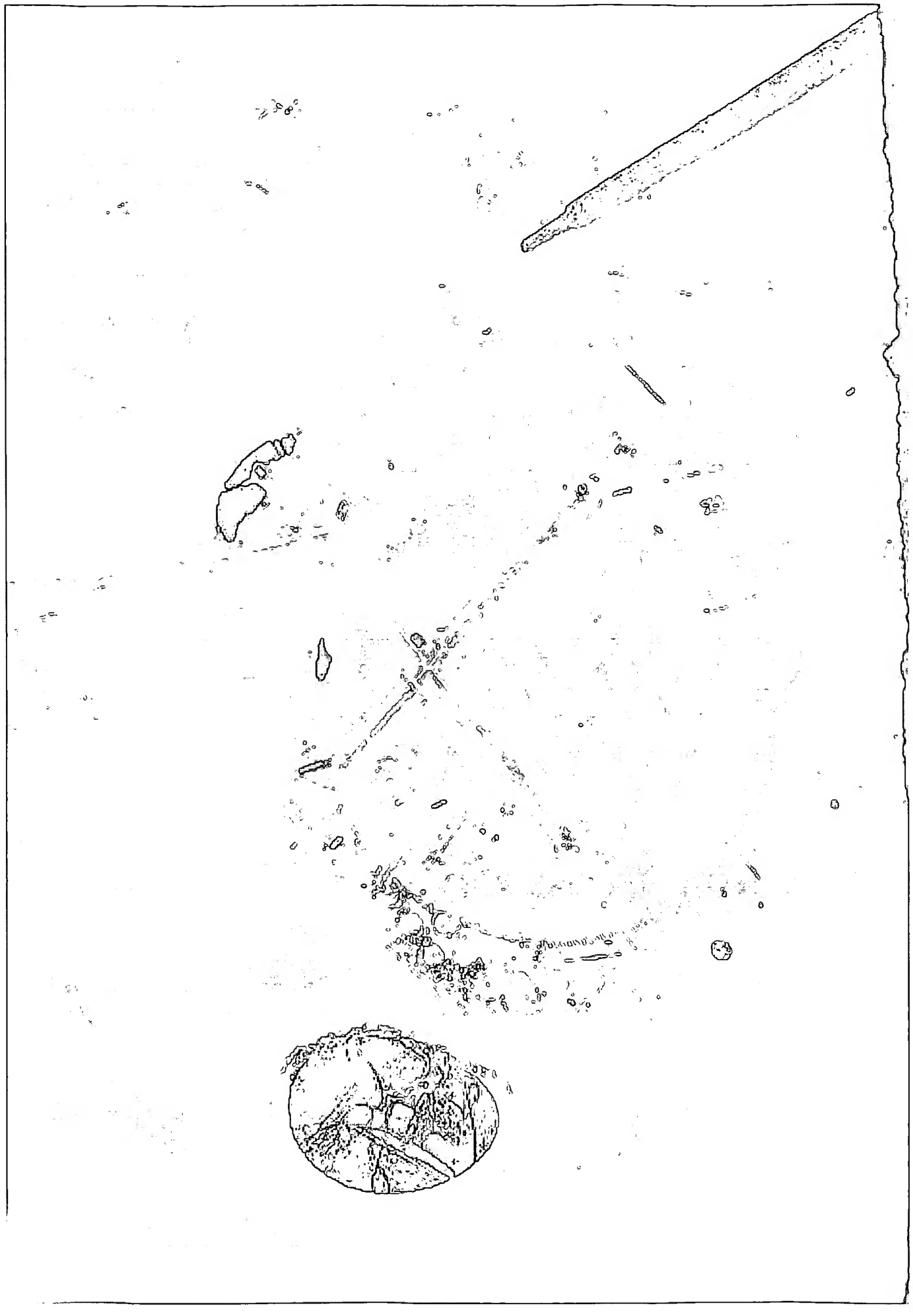
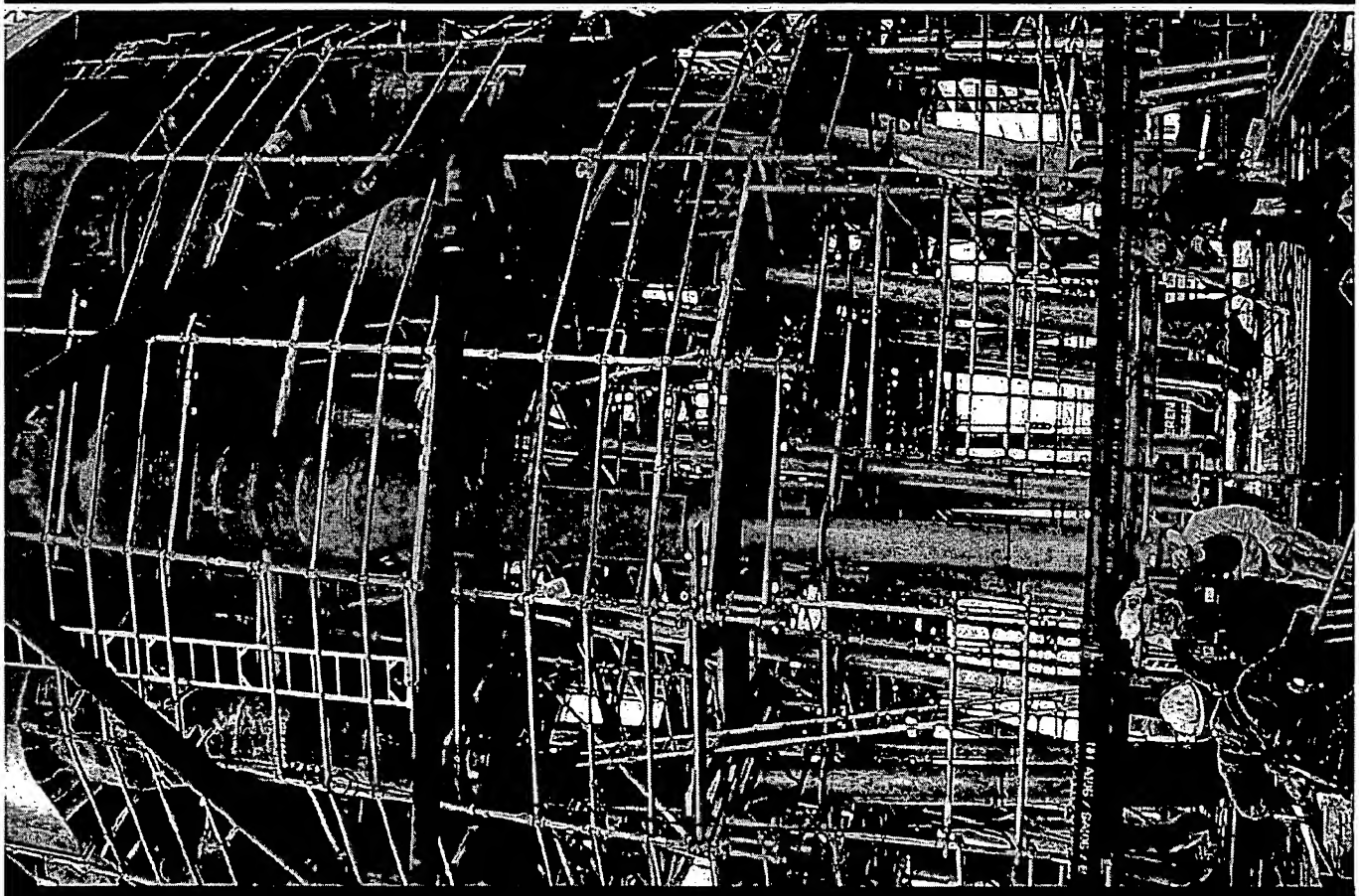
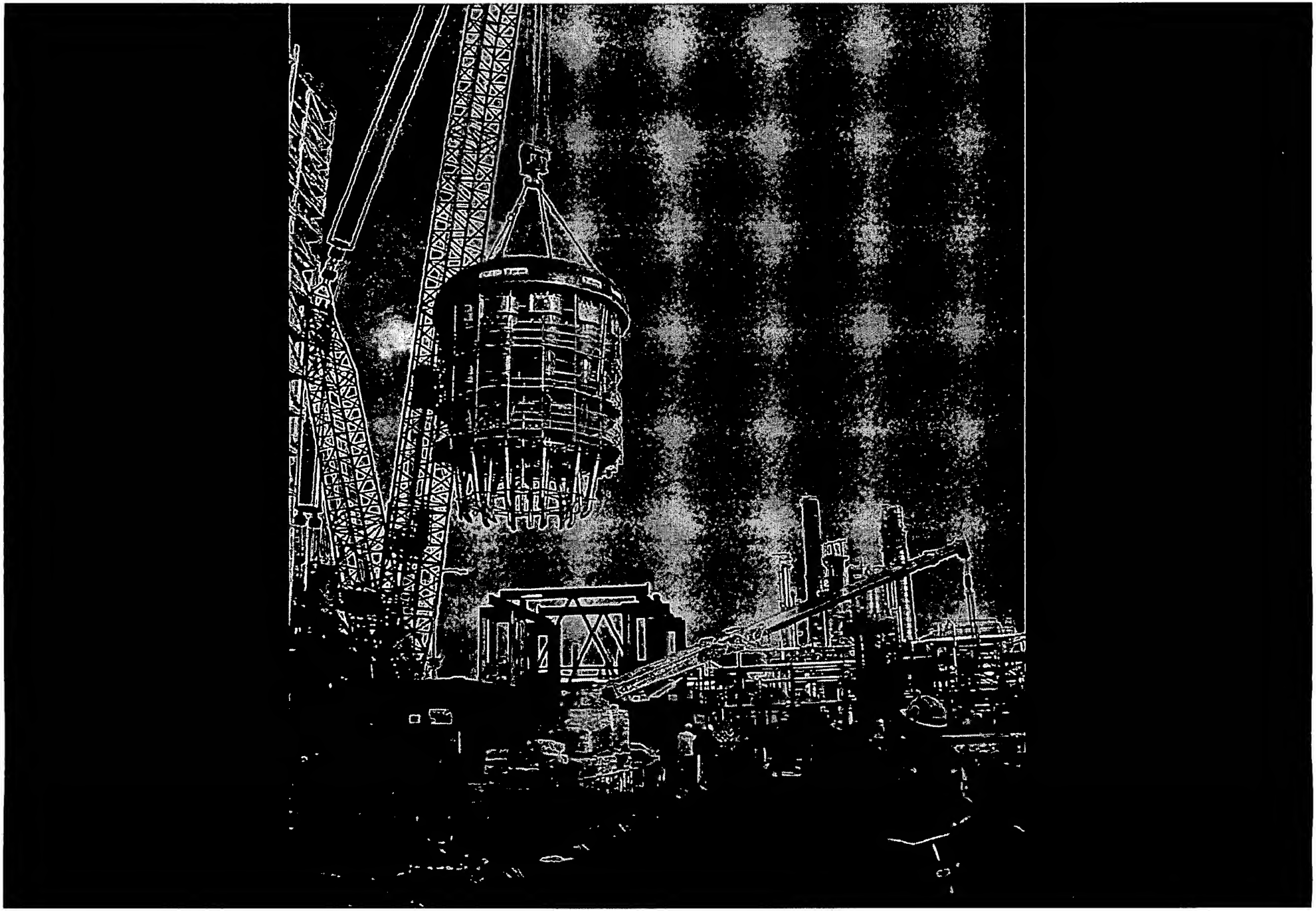
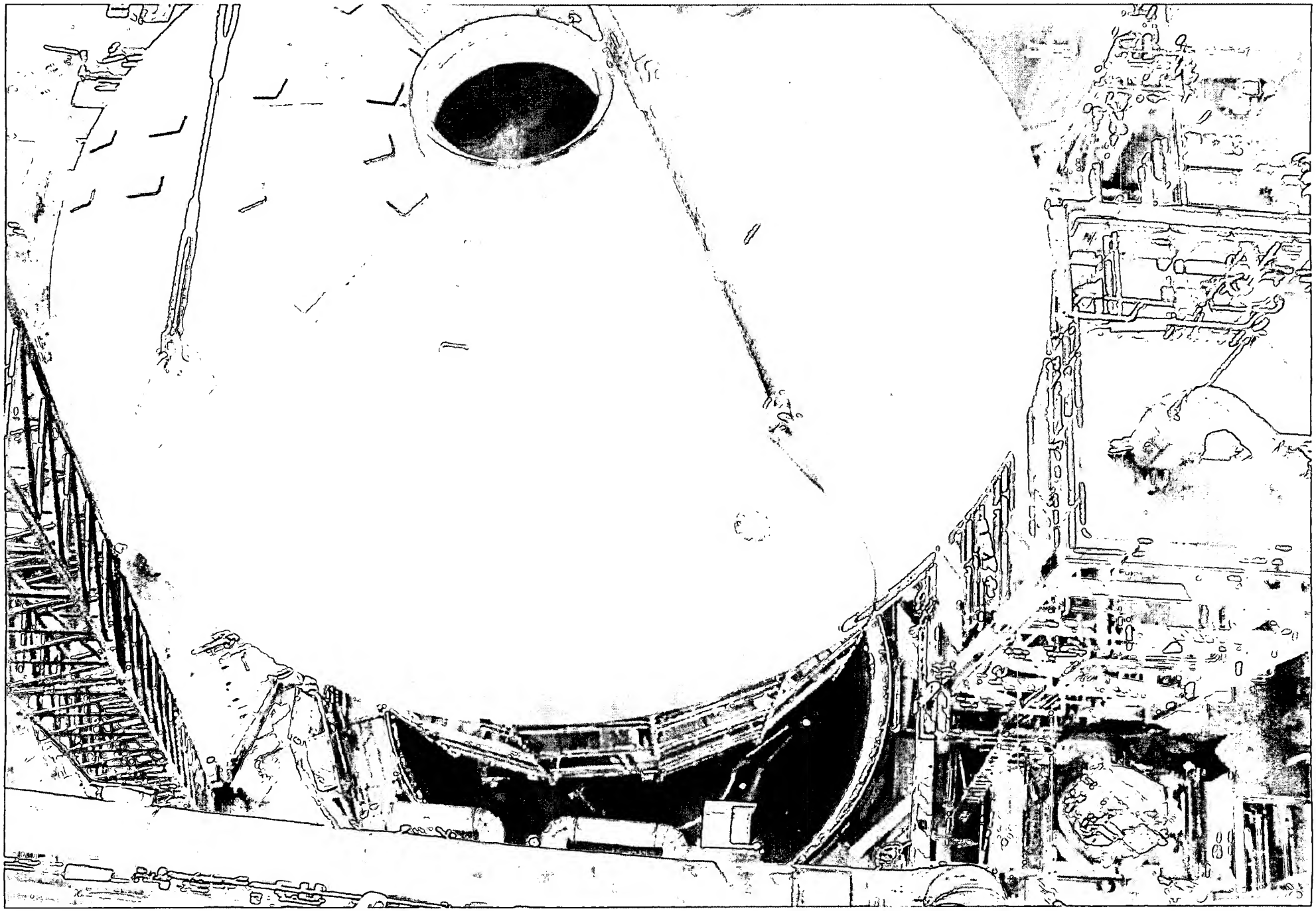
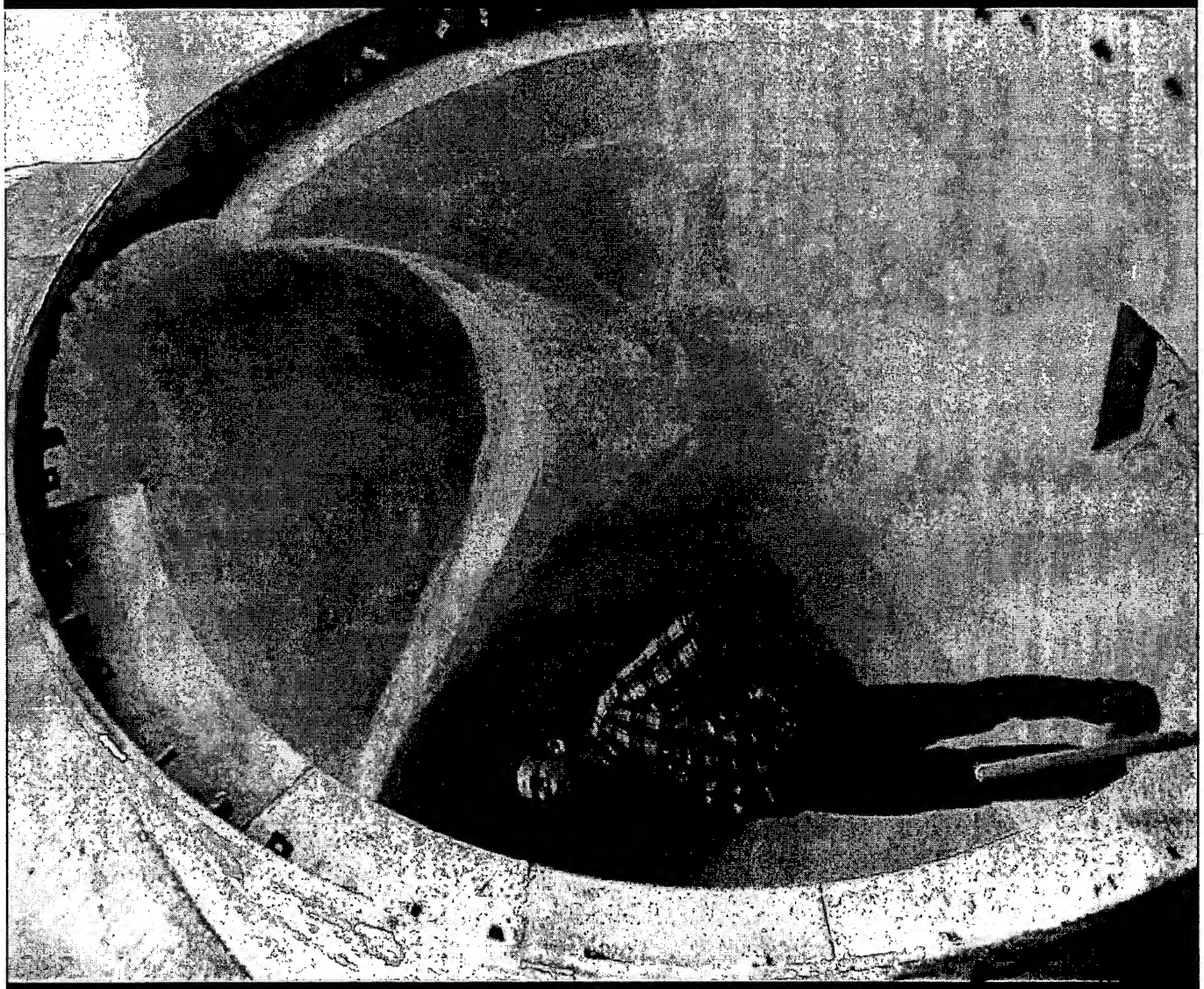


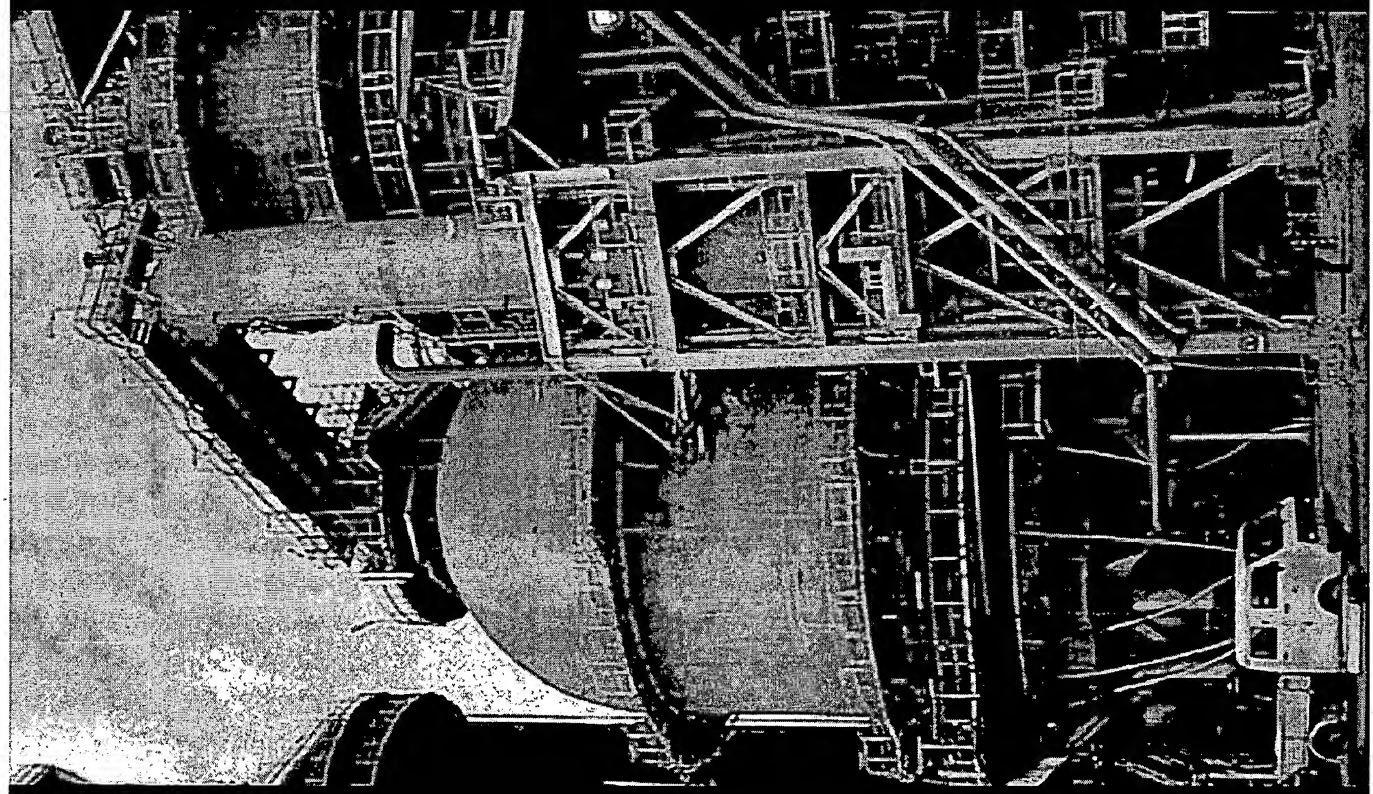








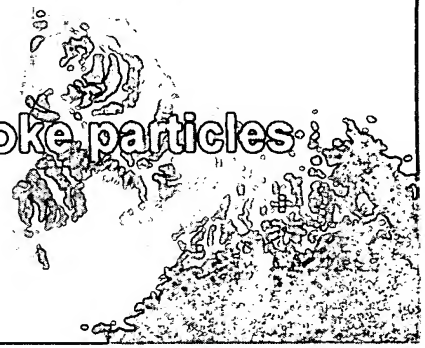


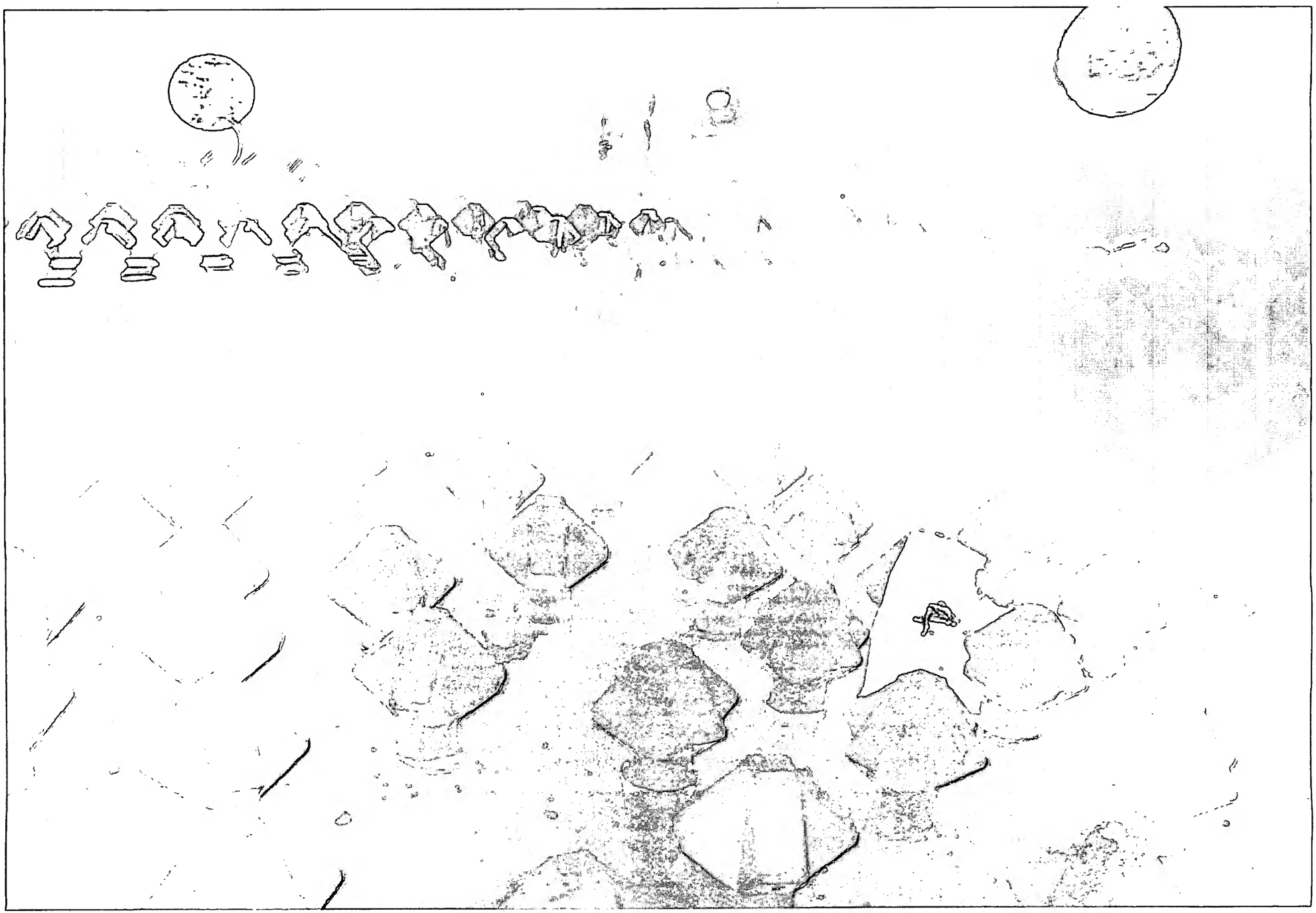


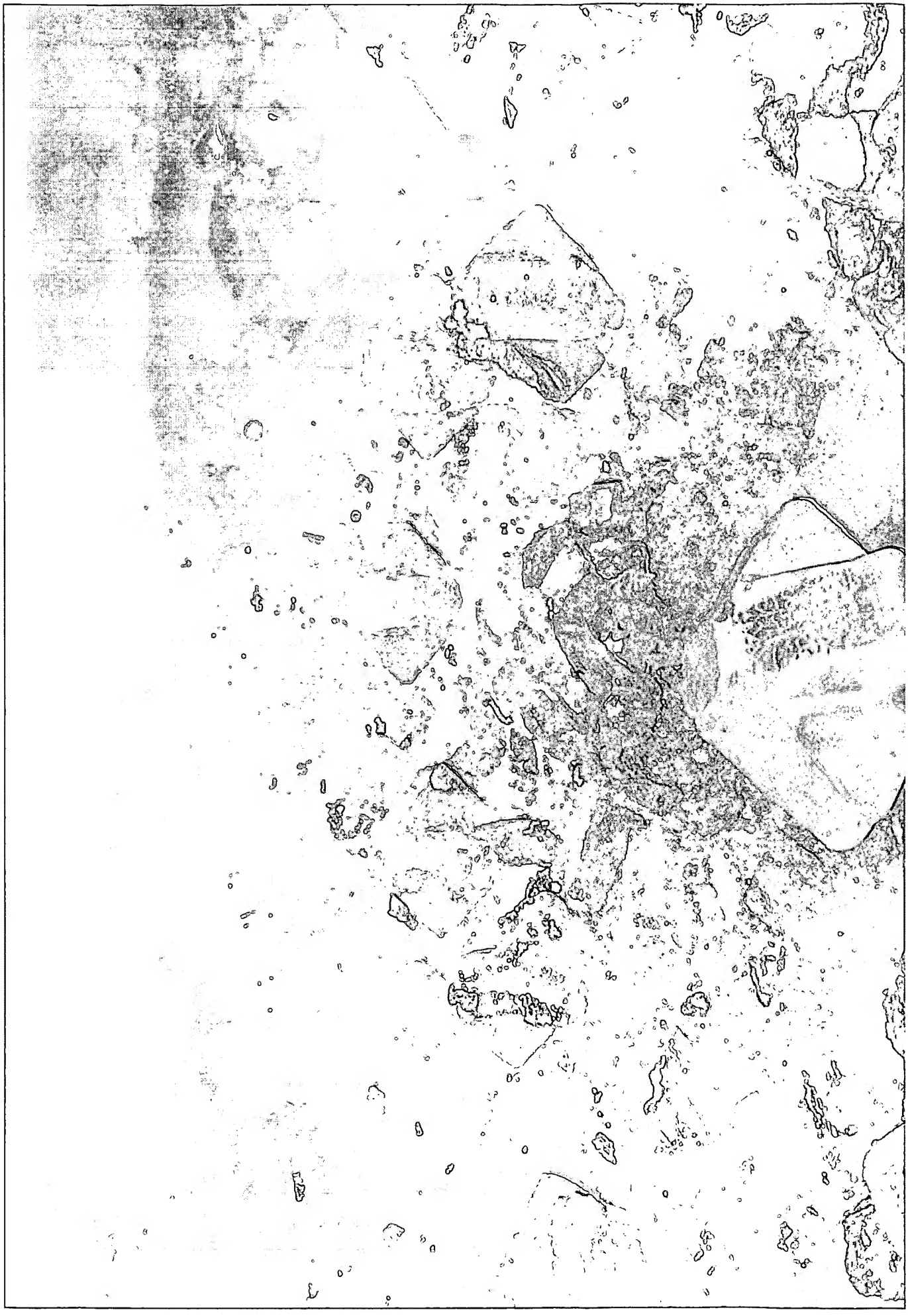
FLEXICOKING Process Description

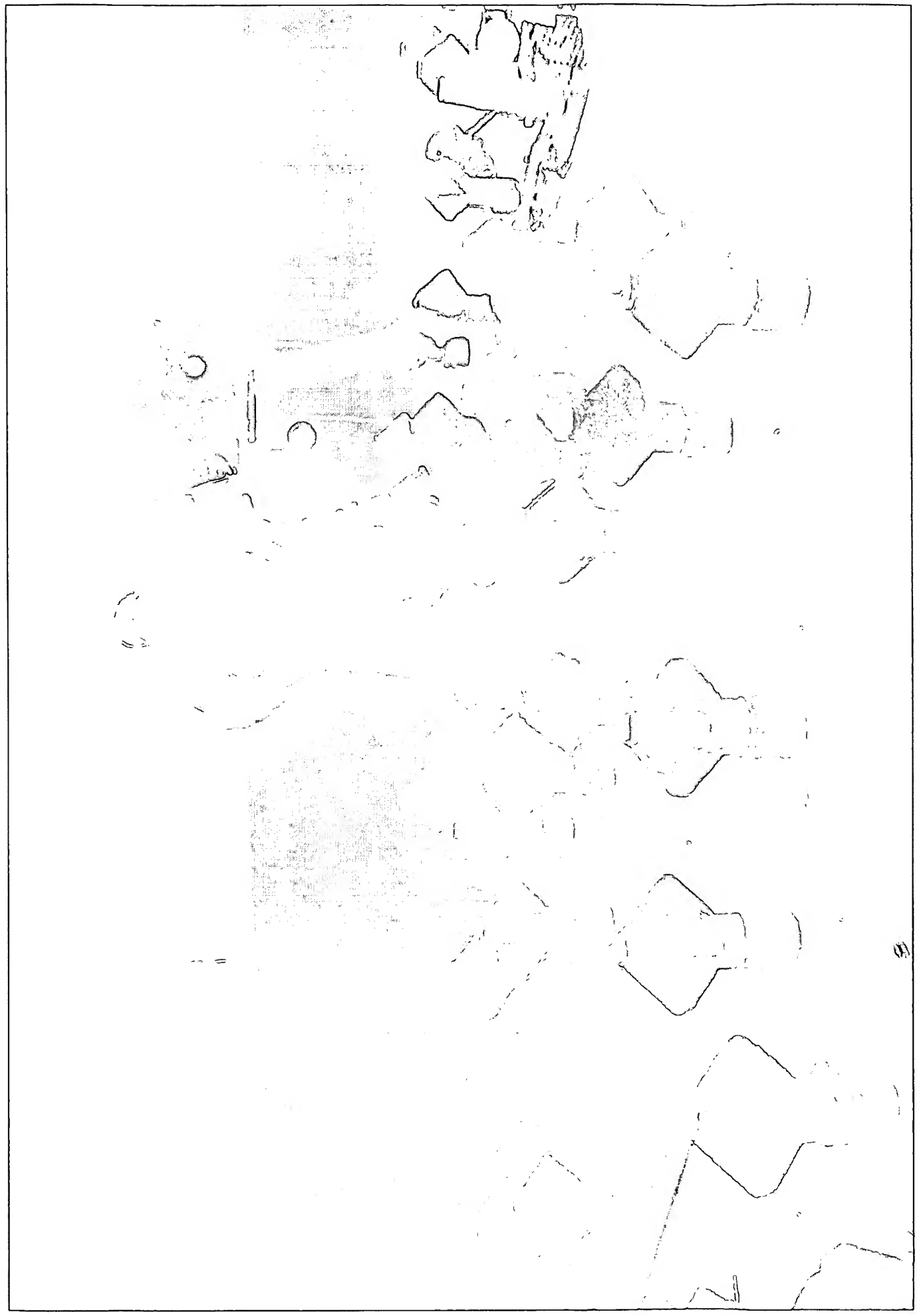
Gasifier

- 900 - 950 °C, 7 meter high fluidized bed, 16 meter diameter
- Coke gasification / combustion
  - $C + \frac{1}{2}O_2 \rightarrow CO$ exo
  - $C + H_2O \rightarrow CO + H_2$ endo
  - $C + CO_2 \rightarrow 2\,CO$ endo
- Gasifies approx. 85-90% of reactor coke production
  - Low Joule Gas contains 50% nitrogen and H_2, CO, CO_2, H_2S and NH_3
  - Temperature control with steam
- Coke circulation for heat transfer and prevents too small coke particles

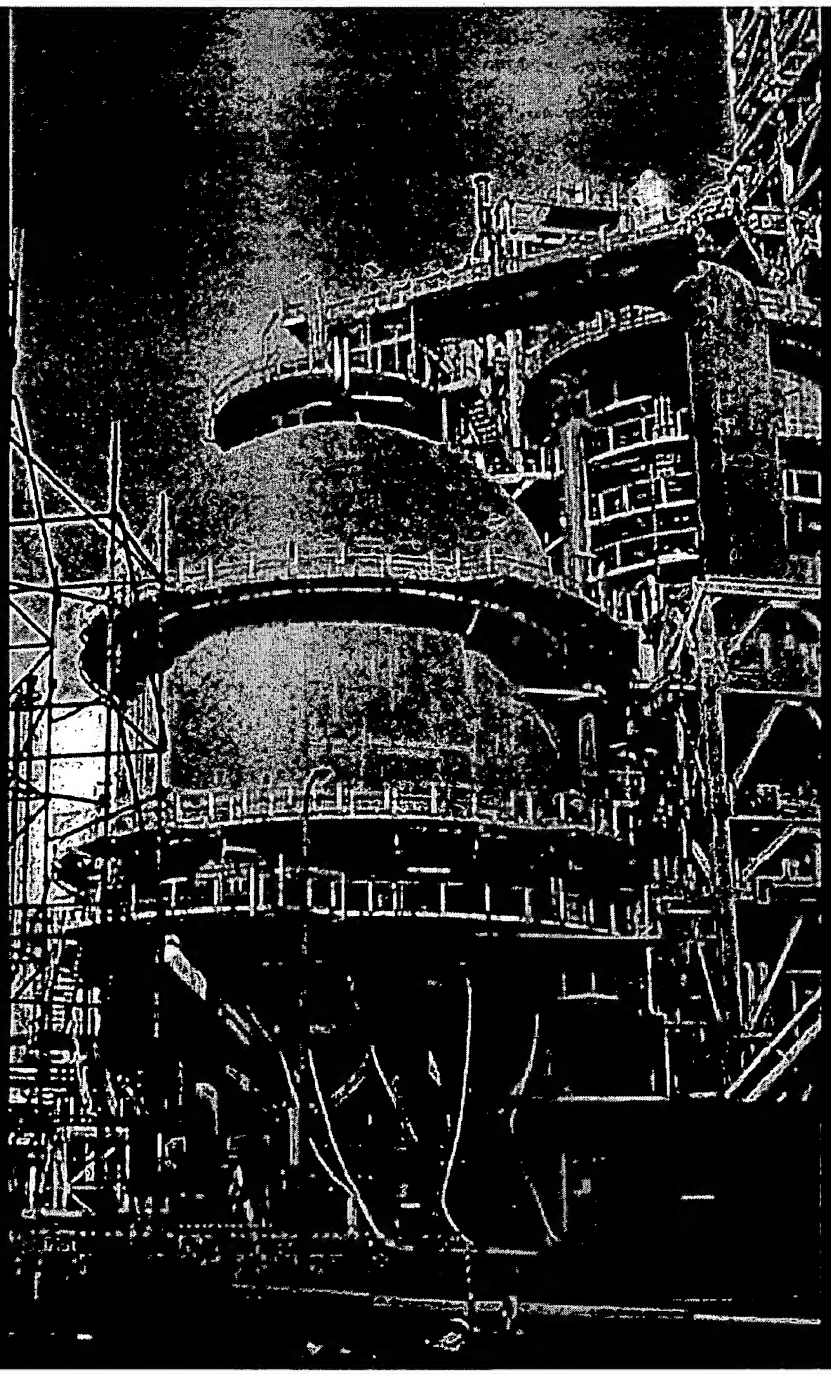


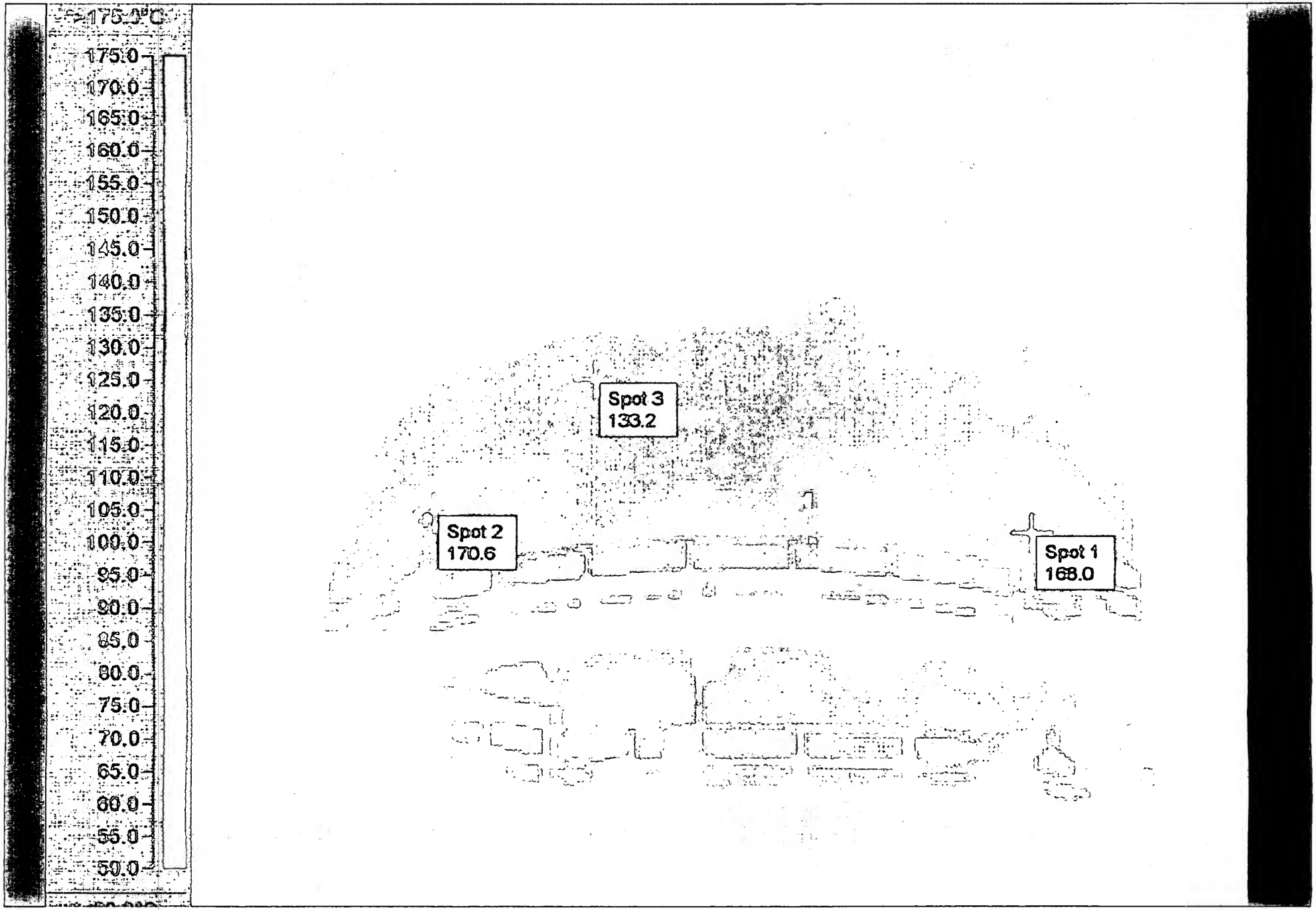






Hot spots




>175.0°C
175.0
170.0
165.0
160.0
155.0
150.0
145.0
140.0
135.0
130.0
125.0
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
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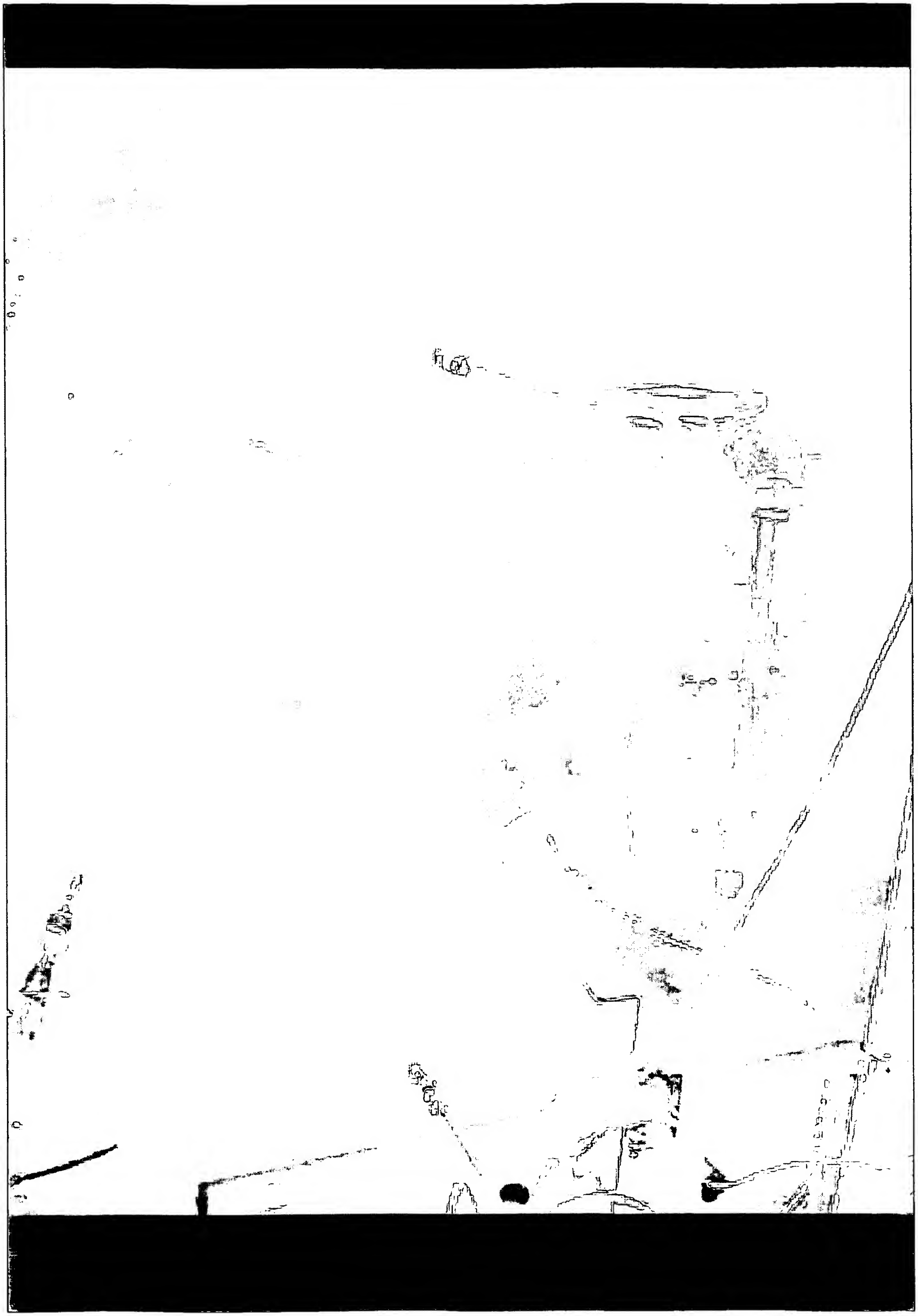
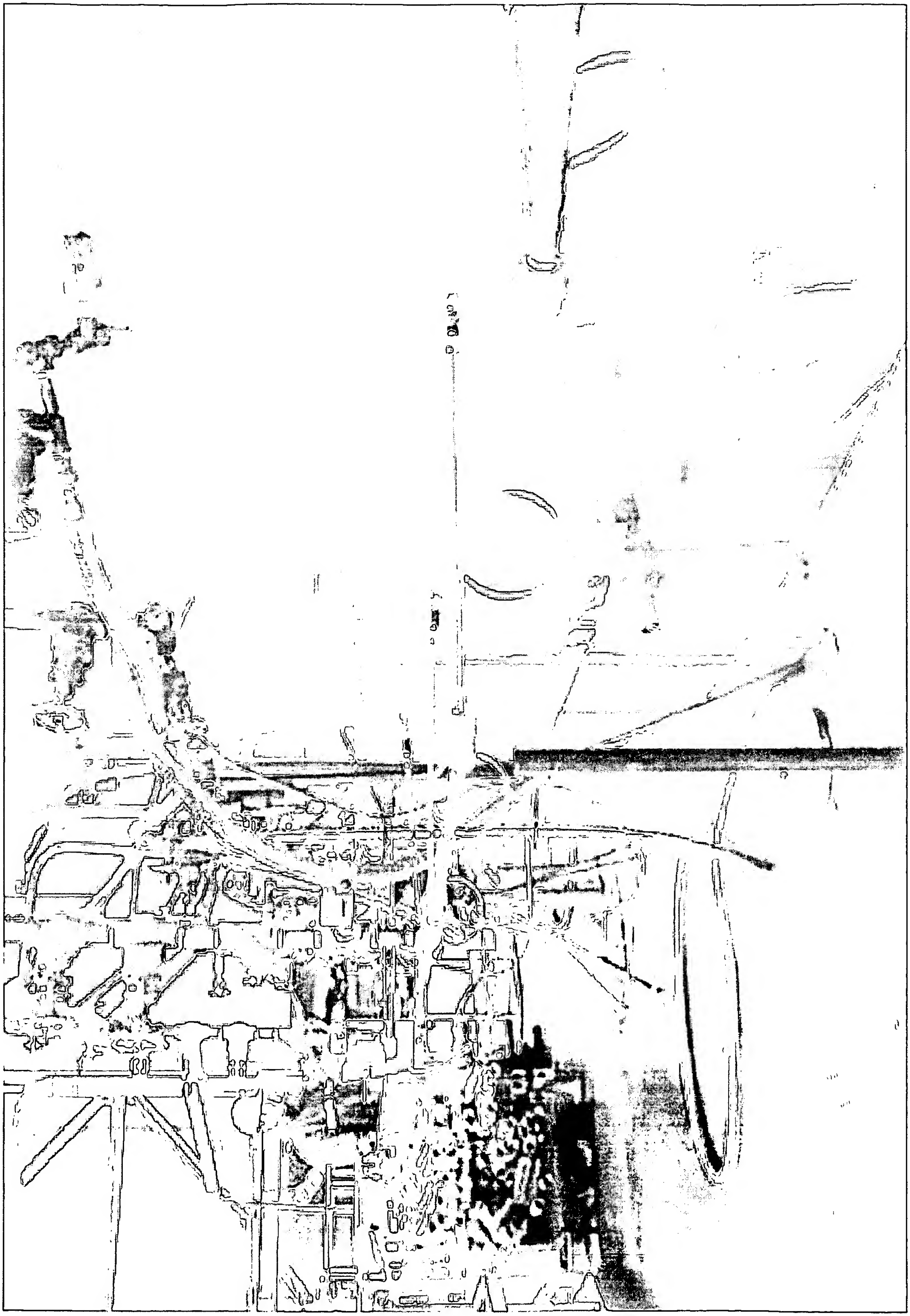
70.0
65.0
60.0
55.0
50.0
Spot 3
133.2
Spot 2
170.6
Spot 1
168.0





FLEXICOKING Process Description

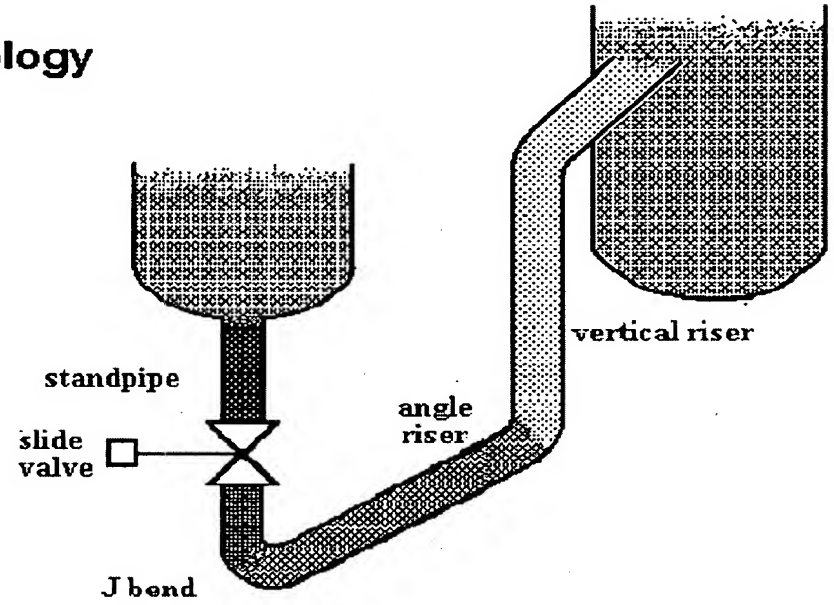
Coke Transfer lines

Guess how many ?

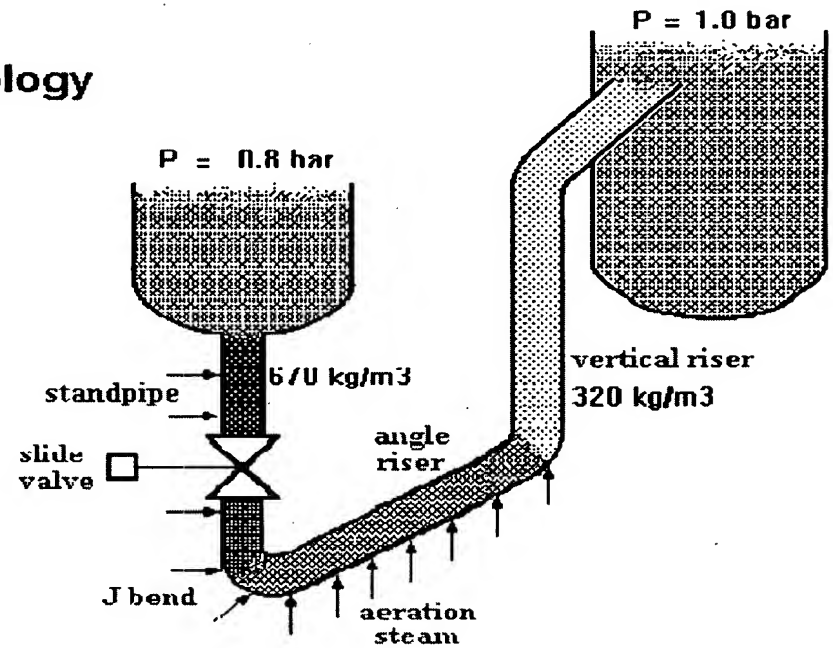
- Rx-Hx 3x
- Hx-Gx 2x
- Hx-Qx 1x

How can you transfer coke against the pressure ?

- **Transfer line terminology**

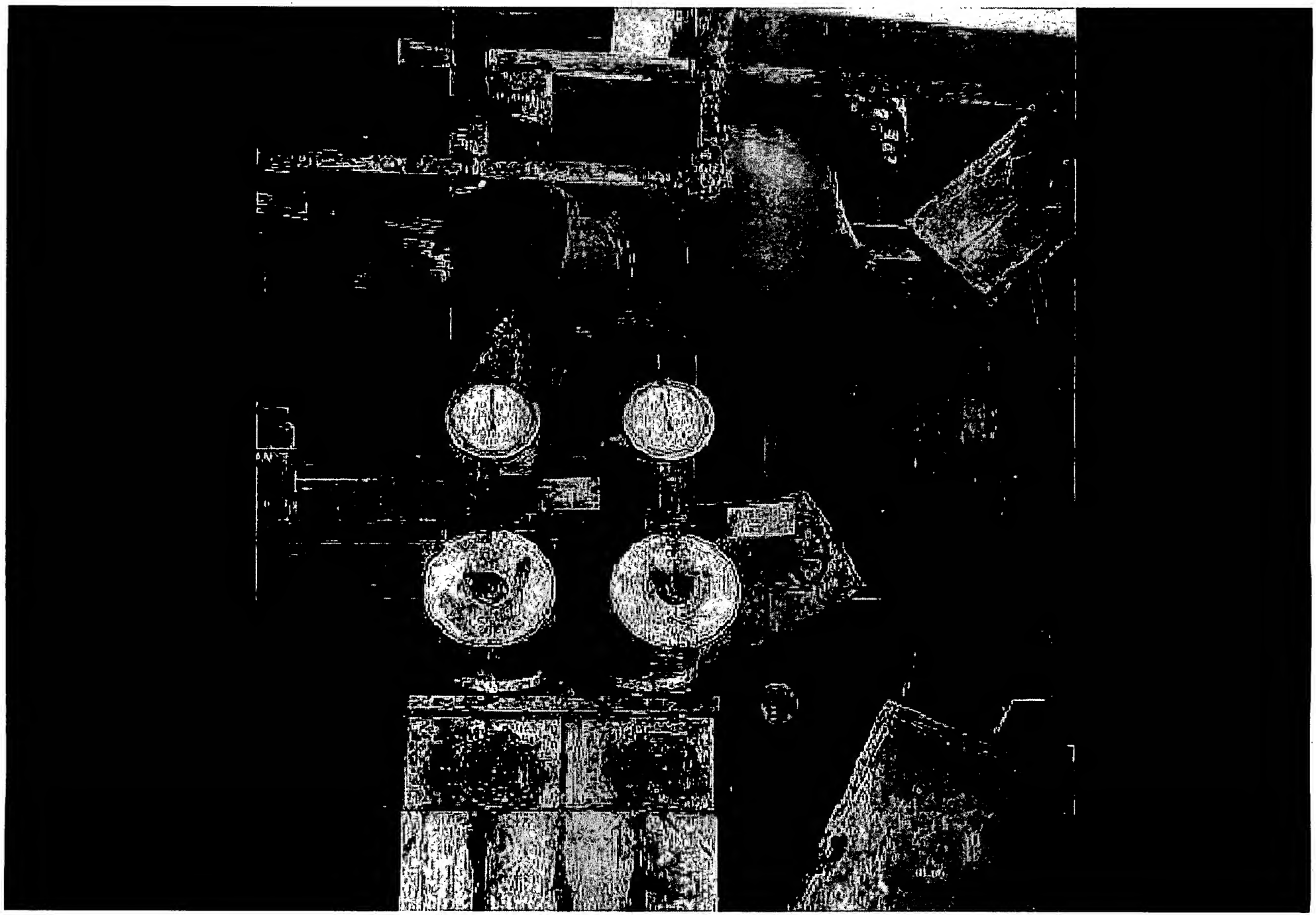


- **Transfer line terminology**

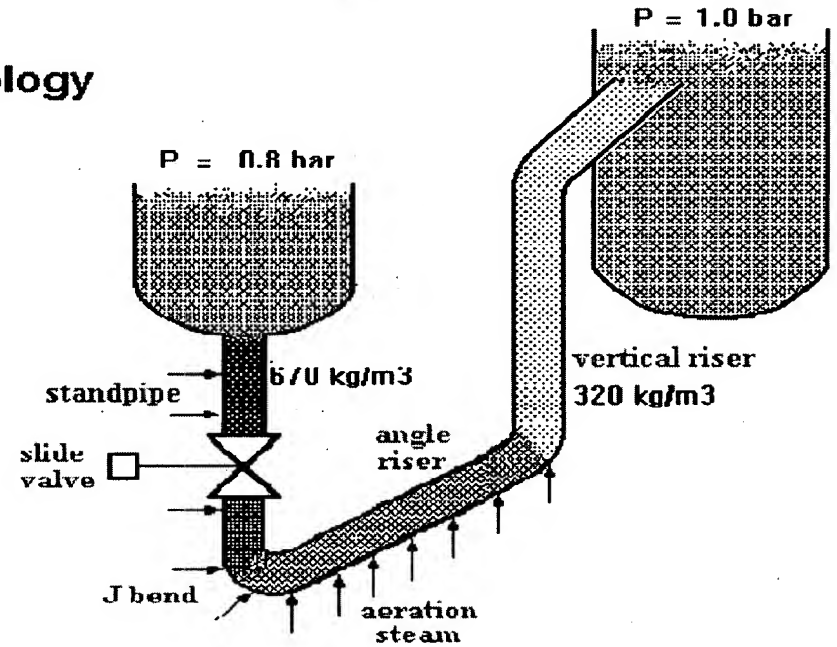


- **Pressure balance**

  static pressure build-up in standpipe provides driving force for coke transport
  flow control by slide valve or riser aerations



- **Transfer line terminology**

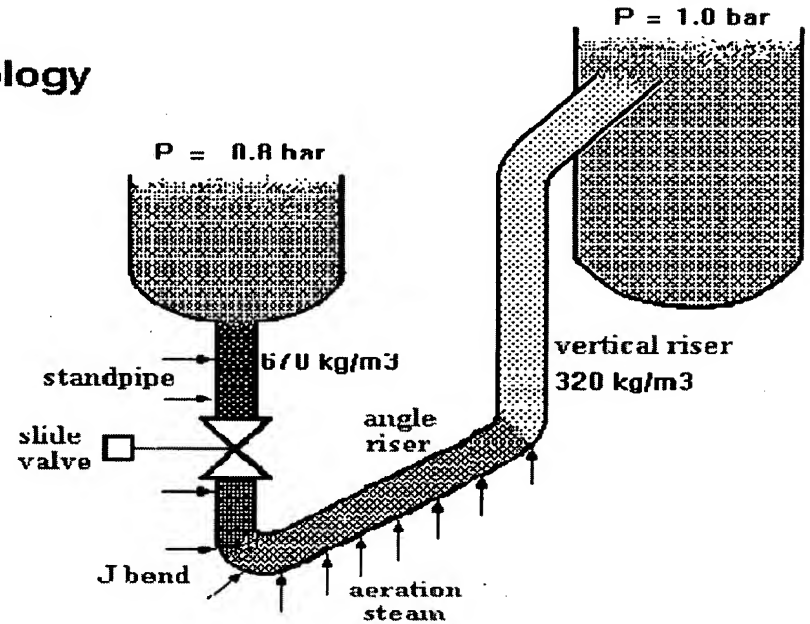


- **Pressure balance**
  - static pressure build-up in standpipe provides driving force for coke transport
  - flow control by slide valve or riser aerations

- **Limitations to aeration**
  - under-aeration in standpipes results in too low pressure build-up
  - too little aeration in risers results in slugging
  - too much aeration in standpipes results in too low density and may cause bubbles
  - too much aeration in risers causes excessive wear

- **"Bubbles up" or "bubbles down"**
  - is determined by velocity differences between gas and particles
  - is important for standpipe aeration

- Transfer line terminology



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Successes and Disappointments over 17 years

- Significant (33%) capacity creep at low cost
- Runlength doubled; reliability is high priority
- 6 out of 7 runs completed as scheduled

- Air Blower problems 1 year after initial start-up
- Severe fouling in Heater Overhead Exchangers
- Gasifier Hot Spots
- Heater maintenance challenges

Reliability and thruput history

Run	Ton/hr	Days on oil
1	202	591
2	229	608
3	254	570
4	258	684
5	262	1048
6	265	1063
7	269	1195

Reliability and thruput history

Reliability increases effective thruput !

- Good process follow-up and stable operation key to success
- DMC controller installed in 2001
- Some hardware changes essential too:
  spare heat exchangers, material upgrading,
  instrumentation upgrading, design changes
  to reduce turnaround time
- Plan for current run is to increased from 3.5 to 4 years

1988-2003 debottlenecks

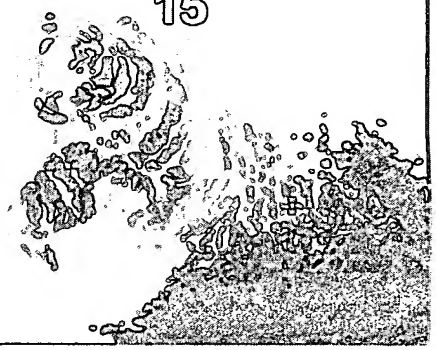
- minor Fluid Solids changes
- 2½ new destillation towers
- replaced a number of pumps
- diverted LPG from LPG/coker naphtha hydrofiner

Stretch run length with care :

Unplanned turnaround has high debits

	MEuro
◦ contractors ask more money for ± same scope	1.5
◦ contractors need 14 days to mobilize	
result is additional downtime	4
◦ turnaround cost spread over shorter run	3.5
◦ coker down means Pipestill down	
jet and diesel to be purchased on spot market	3.5
◦ next run more conservative approach	2.5
◦ total additional cost of unplanned turnaround	15

Partial reactor bog terminated run 2 prematurely



Air Blower problems 1 year after initial start-up

High bearing temperature reading made entire organization nervous

- Serious problem or not ?
- Repair required or do we reach turnaround ?
- How to operate the coker and rest of the refinery ?
- How to minimize risk and costs ?

- 2 day case study chemical + mechanical engineers

FLEXICOKING

- Questions ?